

Quadratic Programming for Allocating Control Effort

A computer program calculates an optimal allocation of control effort in a system that includes redundant control actuators. The program implements an iterative (but otherwise single-stage) algorithm of the quadratic-programming type. In general, in the quadratic-programming problem, one seeks the values of a set of variables that minimize a quadratic cost function, subject to a set of linear equality and inequality constraints. In this program, the cost function combines control effort (typically quantified in terms of energy or fuel consumed) and control residuals (differences between commanded and sensed values of variables to be controlled). In comparison with prior control-allocation software, this program offers approximately equal accuracy but much greater computational efficiency. In addition, this program offers flexibility, robustness to actuation failures, and a capability for selective enforcement of control requirements. The computational efficiency of this program makes it suitable for such complex, real-time applications as controlling redundant aircraft actuators or redundant spacecraft thrusters. The program is written in the C language for execution in a UNIX operating system.

This program was written by Gurkirpal Singh of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (818) 393-2827. Refer to NPO-40592.

Range Process Simulation Tool

Range Process Simulation Tool (RPST) is a computer program that assists managers in rapidly predicting and quantitatively assessing the operational effects of proposed technological additions to, and/or upgrades of, complex facilities and engineering systems such as the Eastern Test Range. Originally designed for application to space transportation systems, RPST is also suitable for assessing effects of proposed changes in industrial facilities and large organizations. RPST follows a model-based ap-

proach that includes finite-capacity schedule analysis and discrete-event process simulation. A component-based, scalable, open architecture makes RPST easily and rapidly tailorable for diverse applications. Specific RPST functions include: (1) definition of analysis objectives and performance metrics; (2) selection of process templates from a process-template library; (3) configuration of process models for detailed simulation and schedule analysis; (4) design of operations-analysis experiments; (5) schedule and simulation-based process analysis; and (6) optimization of performance by use of genetic algorithms and simulated annealing. The main benefits afforded by RPST are provision of information that can be used to reduce costs of operation and maintenance, and the capability for affordable, accurate, and reliable prediction and exploration of the consequences of many alternative proposed decisions.

This program was written by Dave Phillips, William Haas, and Tim Barth of Kennedy Space Center, and Perakath Benjamin, Michael Graul, and Olga Bagatourova of Knowledge Based Systems.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Perakath Benjamin
Knowledge Based Systems
4710 St. Andrews Drive
College Station, TX 77845
Phone: (979) 260-5279
E-mail: Pbenjamin@kbsi.com

Refer to KSC-12511, volume and number of this NASA Tech Briefs issue, and the page number.

Simulator of Space Communication Networks

Multimission Advanced Communications Hybrid Environment for Test and Evaluation (MACHETE) is a suite of software tools that simulates the behaviors of communication networks to be used in space exploration, and predict the performance of established and emerging space communication protocols and services. MACHETE consists of four general software systems: (1) a system for kinematic modeling of planetary and spacecraft motions; (2) a system for characterizing the engineering impact on the

bandwidth and reliability of deep-space and *in-situ* communication links; (3) a system for generating traffic loads and modeling of protocol behaviors and state machines; and (4) a system of user-interface for performance metric visualizations. The kinematic-modeling system makes it possible to characterize space link connectivity effects, including occultations and signal losses arising from dynamic slant-range changes and antenna radiation patterns. The link-engineering system also accounts for antenna radiation patterns and other phenomena, including modulations, data rates, coding, noise, and multipath fading. The protocol system utilizes information from the kinematic-modeling and link-engineering systems to simulate operational scenarios of space missions and evaluate overall network performance. In addition, a Communications Effect Server (CES) interface for MACHETE has been developed to facilitate hybrid simulation of space communication networks with actual flight/ground software/hardware embedded in the overall system.

This work was done by Loren Clare, Esther Jennings, Jay Gao, John Segui, and Winston Kwong of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (818) 393-2827. Refer to NPO-41373.

Computing Q-D Relationships for Storage of Rocket Fuels

The Quantity Distance Measurement Tool is a GIS BASEP computer program that aids safety engineers by calculating quantity-distance (Q-D) relationships for vessels that contain explosive chemicals used in testing rocket engines. (Q-D relationships are standard relationships between specified quantities of specified explosive materials and minimum distances by which they must be separated from persons, objects, and other explosives to obtain specified types and degrees of protection.) The program uses customized geographic-information-system (GIS) software and calculates Q-D relationships in accordance with NASA's Safety Standard For Explosives, Propel-

lants, and Pyrotechnics. Displays generated by the program enable the identification of hazards, showing the relationships of propellant-storage-vessel safety buffers to inhabited facilities and public roads. Current Q-D information is calculated and maintained in graphical form for all vessels that contain propellants or other chemicals, the explosiveness of which is expressed in TNT equivalents [amounts of trinitrotoluene (TNT) having equivalent explosive effects]. The program is useful in the acquisition, siting, construction, and/or modification of storage vessels and other facilities in the development of an improved test-facility safety program.

This program was written by Keith Jester of General Dynamics for Stennis Space Center.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager, Stennis Space Center, (228) 688-1929. Refer to SSC-00209.

Contour Error Map Algorithm

The contour error map (CEM) algorithm and the software that implements the algorithm are means of quantifying correlations between sets of time-varying data that are binarized and registered on spatial grids. The present version of the software is intended for use in evaluating numerical weather forecasts against observational sea-breeze data. In cases in which observational data come from off-grid stations, it is necessary to preprocess the observa-

tional data to transform them into gridded data. First, the wind direction is gridded and binarized so that $D(i,j;n)$ is the input to CEM based on forecast data and $d(i,j;n)$ is the input to CEM based on gridded observational data. Here, i and j are spatial indices representing 1.25-km intervals along the west-to-east and south-to-north directions, respectively; and n is a time index representing 5-minute intervals. A binary value of D or $d = 0$ corresponds to an offshore wind, whereas a value of D or $d = 1$ corresponds to an onshore wind. CEM includes two notable subalgorithms: One identifies and verifies sea-breeze boundaries; the other, which can be invoked optionally, performs an image-erosion function for the purpose of attempting to eliminate river-breeze contributions in the wind fields.

This work was done by Francis Merceret of Kennedy Space Center; John Lane and Christopher Immer of Dynacs, Inc.; and Jonathan Case and John Manobianco of ENSCO, Inc. For further information, contact the Kennedy Innovative Partnerships Office at (321) 867-8130. KSC-12489

Portfolio Analysis Tool

Portfolio Analysis Tool (PAT) is a Web-based, client/server computer program that helps managers of multiple projects funded by different customers to make decisions regarding investments in those projects. PAT facilitates analysis on a macroscopic level, without distraction by parochial concerns or tactical details of

individual projects, so that managers' decisions can reflect the broad strategy of their organization. PAT is accessible via almost any Web-browser software. Experts in specific projects can contribute to a broad database that managers can use in analyzing the costs and benefits of all projects, but do not have access for modifying criteria for analyzing projects: access for modifying criteria is limited to managers according to levels of administrative privilege. PAT affords flexibility for modifying criteria for particular "focus areas" so as to enable standardization of criteria among similar projects, thereby making it possible to improve assessments without need to rewrite computer code or to rehire experts, and thereby further reducing the cost of maintaining and upgrading computer code. Information in the PAT database and results of PAT analyses can be incorporated into a variety of ready-made or customizable tabular or graphical displays.

This program was written by Tim Barth and Edgar Zapata of Kennedy Space Center, and Perakath Benjamin, Mike Graul, and Doug Jones of KBSI, Inc.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

*Perakath Benjamin
Knowledge Based Systems, Inc.
1408 University Drive East
College Station, TX 77840
Phone: (979) 260-5274*

Refer to KSC-12510, volume and number of this NASA Tech Briefs issue, and the page number.